

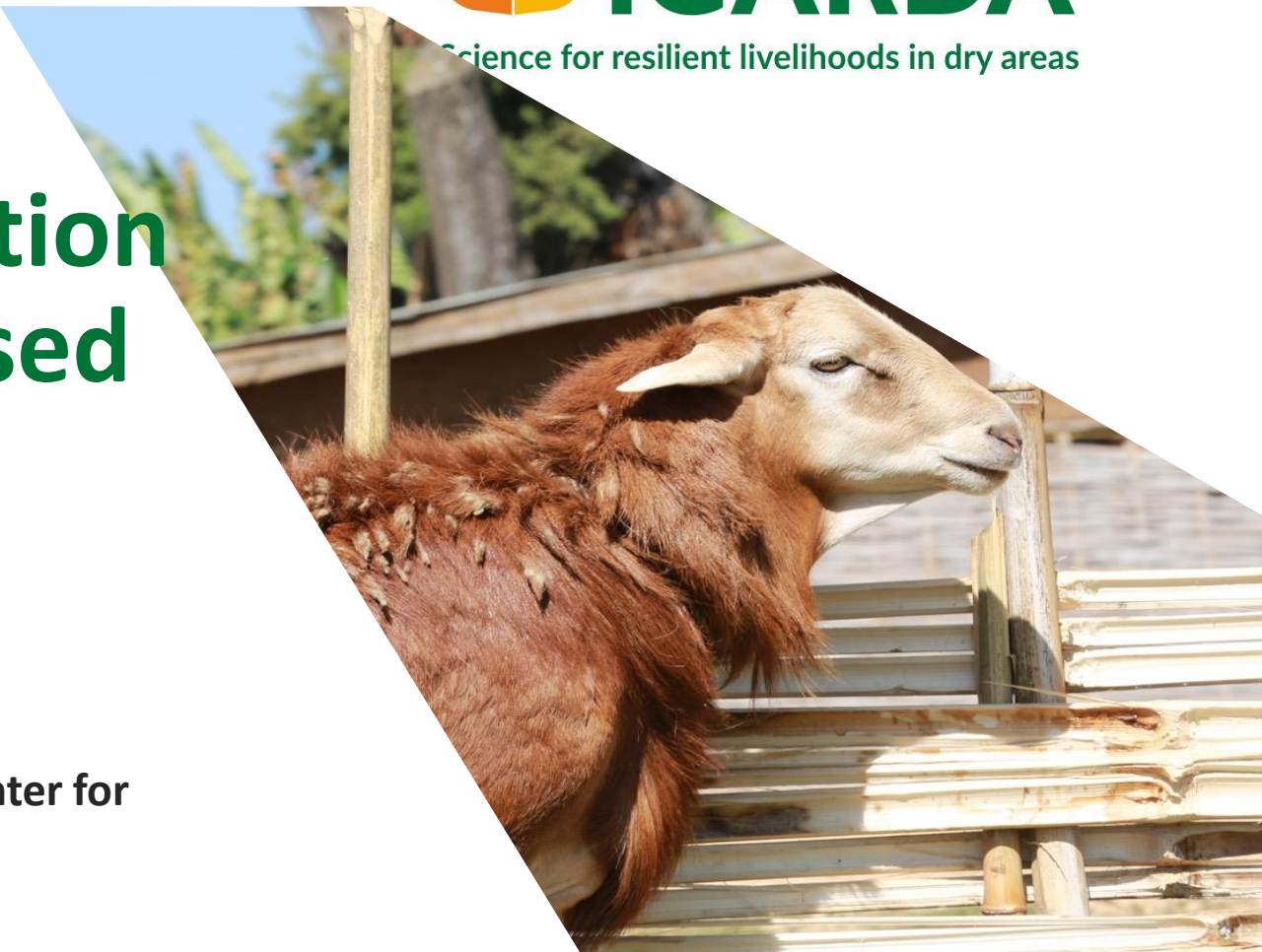


AICCRA
Accelerating Impacts of CGIAR
Climate Research for Africa



Science for resilient livelihoods in dry areas

Enhancing Resilience and Advancing Climate Mitigation through a Community-Based Breeding Approach



Aynalem Haile and Tesfaye Getachew - International Center for Agricultural Research in the Dry Areas (ICARDA)

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icarda.org

International Center for Agricultural Research in the Dry Areas



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Contents

- GHG emission facts
- Climate Smart Agriculture
- Community-based breeding and integrated innovations
- Roles of CBBP on the environment
 - Increase productivity
 - Climate mitigation

Greenhouse gas (GHG) emission facts:

- **Carbon Dioxide (CO₂):** CO₂ is the most prevalent greenhouse gas emitted by human activities.
 - It is primarily released through the burning of fossil fuels such as coal, oil, and natural gas for energy production, transportation, and industrial processes.
- **Methane (CH₄):** Methane is a potent greenhouse gas with a higher warming potential than CO₂ over a shorter time frame.
 - It is emitted from various sources, including livestock digestion, agricultural practices, natural gas production and distribution, and the decay of organic waste in landfills.
- **Nitrous Oxide (N₂O):** N₂O is released from agricultural and industrial activities, as well as the burning of fossil fuels and solid waste.
- **The IPCC** assesses GHG emission, atmospheric CO₂ conc., develops emissions scenarios to explore different trajectories of future GHG emissions and their potential impacts on climate change.
 - Help policymakers and researchers understand the range of possible futures based on different socioeconomic and technological pathways.

Global CO₂-equivalent emissions by sector

- **Energy Sector:** 35% to 75% of global CO₂-equivalent emissions, includes Electricity and Heat Production, fossil Fuel Combustion (coal mining, oil and gas extraction)
- **Industry:** Contributes to around 20% to 30% of global emissions. This sector encompasses emissions from manufacturing processes, cement production, and chemical industries.
- **Transportation:** Road Vehicles: Contribute to around 14 to 24 % of global CO₂-equivalent emissions.
- **Livestock Sector:** Contributes to roughly 14% to 18% of global emissions. This includes emissions from enteric fermentation (digestive processes) in ruminant animals (such as cows and sheep), manure management, and other livestock-related activities.
- **Agriculture (Non-Livestock):** Contributes to about 7% to 14% of global emissions. This sector includes emissions from rice cultivation, synthetic fertilizer use, crop residue burning, and other agricultural practices excluding livestock
- **Residential and Commercial Buildings:** Contributes to approximately 6% to 17% of global emissions. Emissions arise from energy use for heating, cooling, lighting, and appliances in residential and commercial buildings.
- **Waste Management:** Contributes to around 2% to 5% of global emissions. Emissions mainly come from the decomposition of organic waste in landfills and the release of methane gas.

Pillars of Climate smart agriculture (CSA)

- **Productivity:**
 - Improved livestock breeds that are more productive and resilient to climate stresses
 - Implementing sustainable intensification practices
- **Adaptation:**
 - Climate change is already impacting agricultural systems worldwide, and adaptation measures are necessary to build resilience and minimize the negative impacts
 - Developing climate-resilient livestock breeds that are better adapted to changing climatic conditions.
 - Enhancing early warning systems and climate information services to support farmers
- **Mitigation:**
 - Improving livestock breeding/management practices to reduce enteric fermentation and manure-related methane emissions
 - Genetic selection for lower emission, feed efficiency and lower methane production per feed intake
 - Improved feeding practices to reduce methane emission

**Is community-based breeding
program climate smart?**

Community-based breeding program



Community-based breeding programs (CBBPs) for sheep and goats

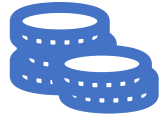


Started in 2009

Impacts



Acceptable genetic advancement has been made



Sale volume and income



meat consumption



Farmers participation increased



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doi:10.1017/S1751731120000269



Tropical Animal Health and Production (2021) 53: 42
<https://doi.org/10.1007/s11250-020-02445-w>

REGULAR ARTICLES



Community-based sheep breeding programs generated substantial genetic gains and socioeconomic benefits

Estimates of genetic parameters and trends for reproduction traits in Bonga sheep, Ethiopia

A. Haile^{1†}, T. Getachew¹, T. Mirkena², G. Duguma³, S. Gizaw⁴, M. Wurzinger⁵, J. Soelkner⁵, O. Mwai⁶, T. Dessie⁴, A. Abebe⁷, Z. Abate⁸, T. Jembere⁹, M. Reki¹, R. N. B. Lobo¹⁰, J. M. Mwacharo¹, Z. G. Terfa¹, G. T. Kassie¹, J. P. Mueller¹¹ and B. Rischkowsky¹

Asrat Tera¹ · Tesfaye Getachew² · Aberra Melesse³ · Mourad Reki² · Barbara Rischkowsky² · Joram M. Mwacharo² · Zelalem Abate⁴ · Aynalem Haile²

frontiers
in Veterinary Science

ORIGINAL RESEARCH
published: 29 July 2021
doi: 10.3389/fvets.2021.610610



Welfare Impact of Community-Based Veterinary and Breeding Services on Small Ruminant Keepers

Girma Tesfahun Kassie^{1*}, Woinishet Asnake², Aynalem Haile², Tesfaye Getachew Mengistu⁴, Solomon Gizaw³ and Barbara Rischkowsky²

Community-based breeding program

- CBBP is an **alternative** genetic improvement program
- Smallholder farmers **pooling small flocks** for genetic improvement
- **Cooperatives** facilitate sharing of improved rams and market linkages
- Creates a conducive **genetic database** for genetic improvement through selection
- Data is generated using **enumerators** for decision-making based on Estimated Breeding Values (EBVs)



SmaRT Pack Intervention

Genetics

Improved feeding practices

Animal health interventions

Market access

Creating an enabling environment with capacity building and inclusiveness

CBBP and Climate Smart Agriculture (CSA)

We believe CBBP and integrated innovations are well aligned with CSA pillars

- **Genetic improvement** for productivity (growth, milk, reproduction)
- Ensures **adaptability**: Identification and utilization of livestock breeds/species adapted to local climatic conditions
- **Breeding practices** like culling of unproductive animals and improving off-take rate
- **Reduced time to market**: Market facilitation and digital marketing to optimize off-take and reduce emissions
- **Enhanced growth rates** often correlate with improved feed efficiency
- **Multi-Trait Selection** approaches that consider both productivity and GHG emissions

Evaluating the Environmental Impact of Community-Based Breeding Practices

Approach:

Assess productivity for growth, reproduction and adaptation traits

- Geneti analysis
- General linear model analysis
- **CLEANED** – (Comprehensive Livestock Environmental Assessment for improved Nutrition, a secured Environment and sustainable Development along livestock value chains) was used to evaluate impact of CBBPs and integrated interventions on the environment
- Menz and Bonga sheep CBBP were considered – targets 2 million sheep
- Two scenarios – Baseline and improved were considered

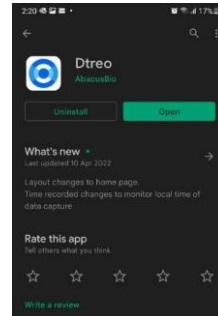
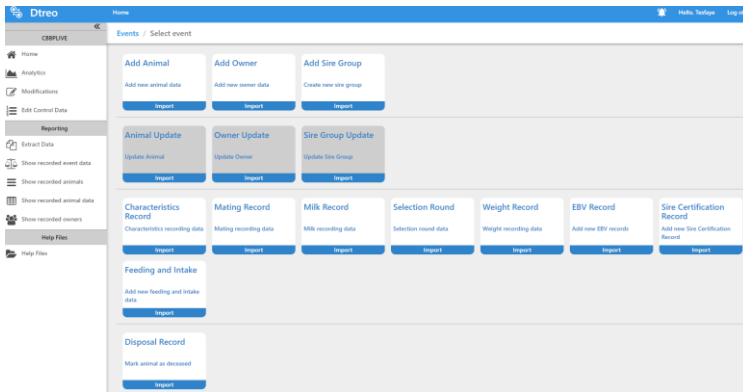
Data were accessed from a digital genetic database - DTREO

Online <https://dtreo.io/>

Username:

Password:

Dtreo events – for data capture



breeding data: 124K lambing/kidding, 200K live weight, from 69 CBBPs and 60 joined recently and loading their data

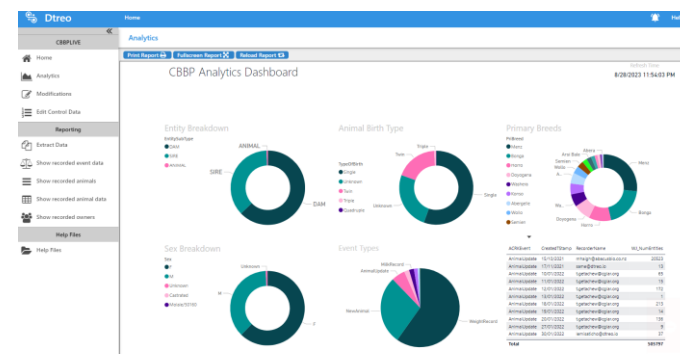
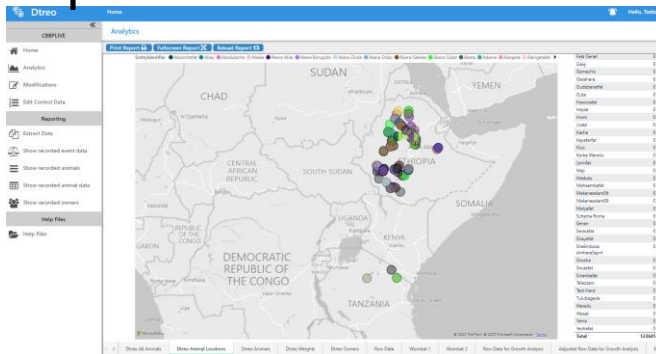


Also captures feed intake and performance



Data can be accessible for genetic evaluation

Analytic tab – Graphical and spreadsheet reports



- Input files for other programs like WOMBAT
- Ultimate goal - Calculating EBV with just one click

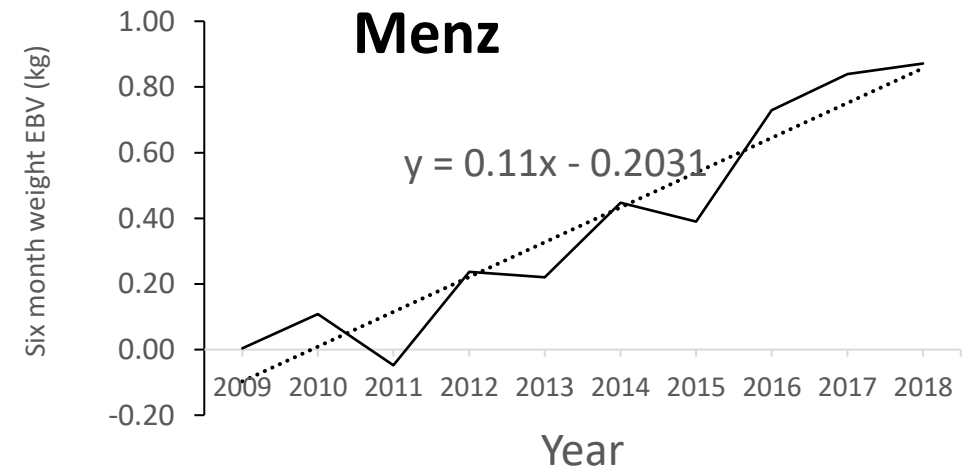
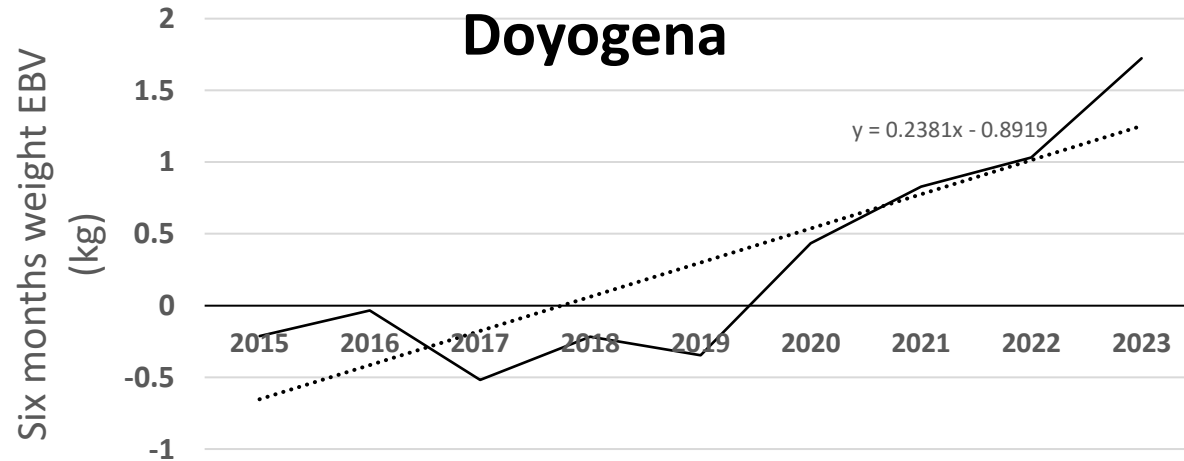
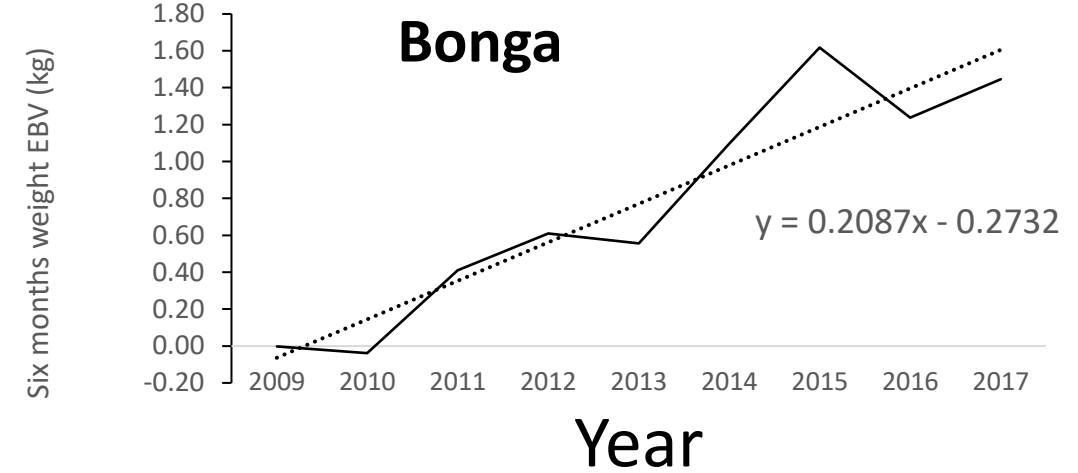
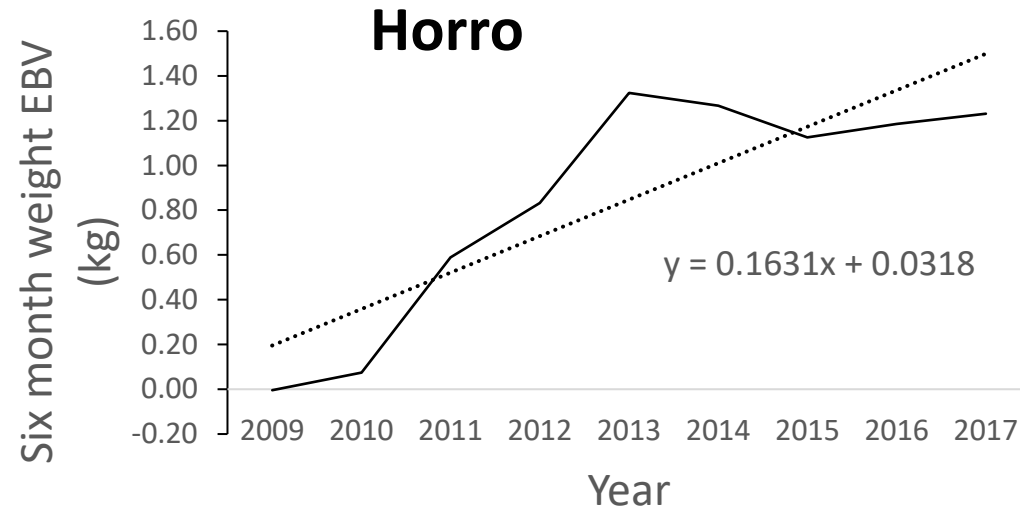
Results – Performance

Genetic parameter estimates for different growth traits in Menz sheep breed

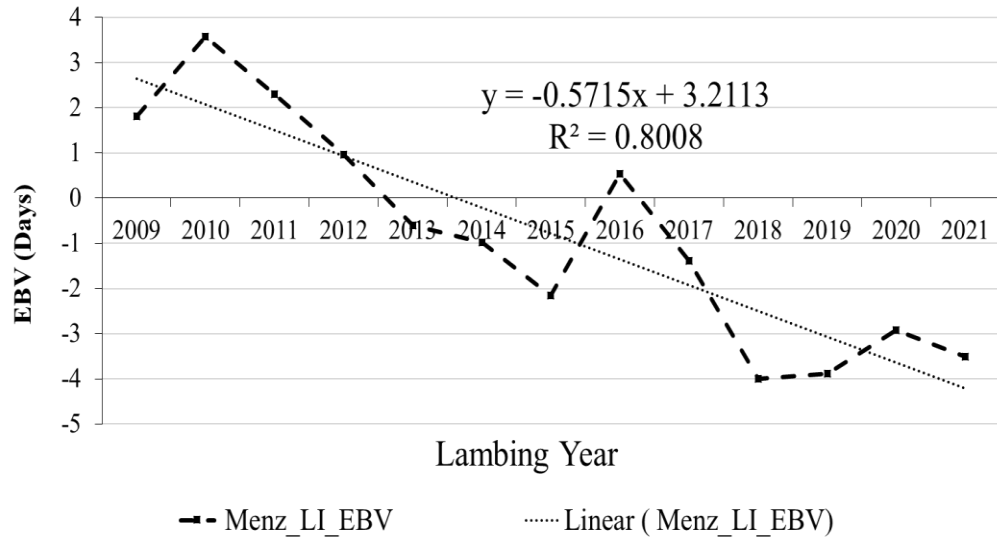
Traits	σ^2_a	σ^2_m	σ^2_e	σ^2_P	h^2_a	h^2_t
BW	0.060		0.148	0.208	0.29 \pm 0.01	
WW	1.412	0.112	1.596	3.120	0.45 \pm 0.01	0.47
6MW	1.691	0.089	1.871	3.651	0.46\pm0.02	0.47
YW	2.572		3.503	6.075	0.42 \pm 0.02	0.42 \pm 0.02
ADG1	162.13	7.303	200.91	370.343	0.44 \pm 0.01	0.44
ADG2	271.82		463.34	735.16	0.37 \pm 0.02	0.37 \pm 0.02
ADG3	104.79		404.77	509.56	0.21 \pm 0.02	0.21 \pm 0.02

σ^2_P phenotypic variance; σ^2_a additive variance; σ^2_m maternal variance; σ^2_c maternal permanent environmental effects; σ^2_e error variance; h^2_a direct heritability; h^2_m maternal heritability; h^2_c variation of maternal permanent environmental effects to the total phenotypic variance; h^2_t total heritability; r_{am} genetic correlation between direct and maternal additive heritability; σ_{am} .covariance between direct and maternal additive genetic effect; CV_A additive coefficient of variance; Log (L) log Likelihood. BW: birth weight, WW: weaning weight, 6MW: six months weight, YWT: yearling weight ADG1: average daily gain from birth to weaning, ADG2: average daily gain from weaning to six months, ADG3: daily gain from six months to yearling.

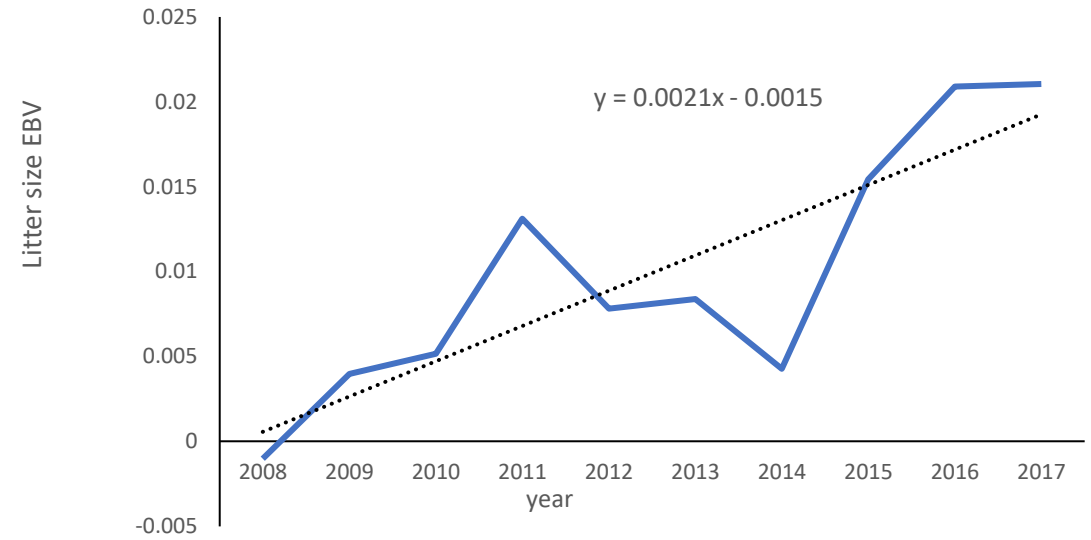
Genetic trend for six months weight in different sheep breeds



Genetic trends



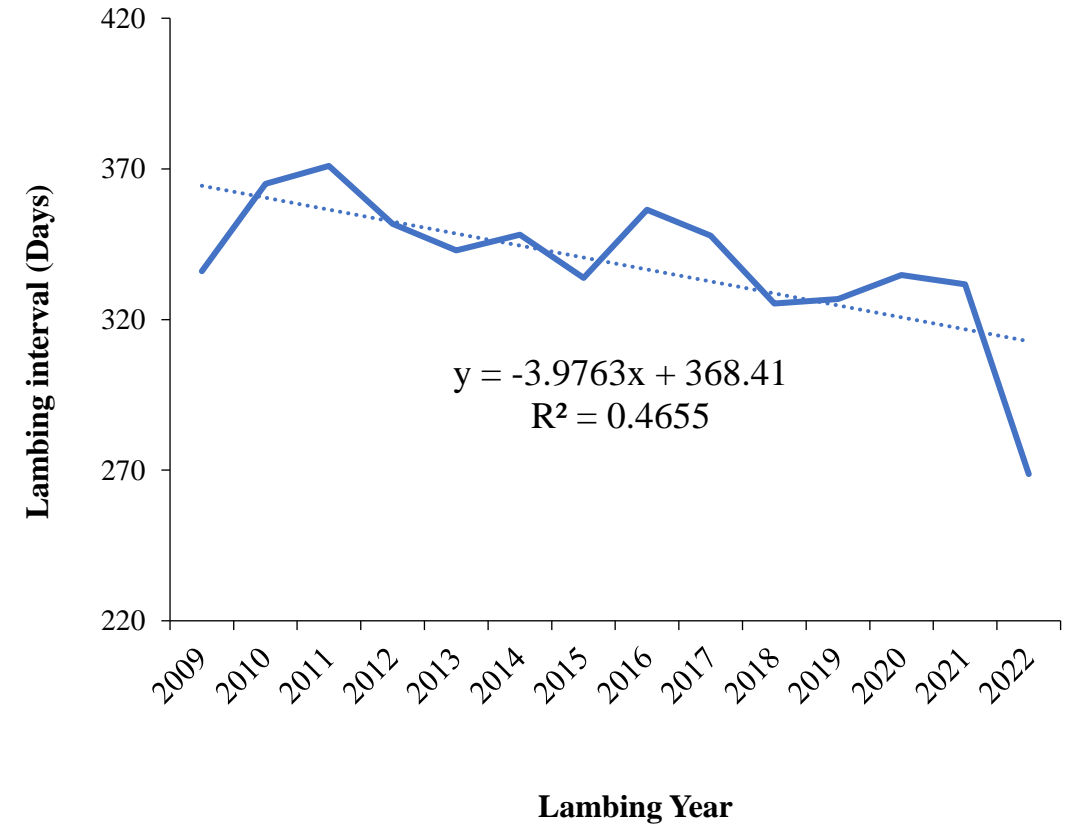
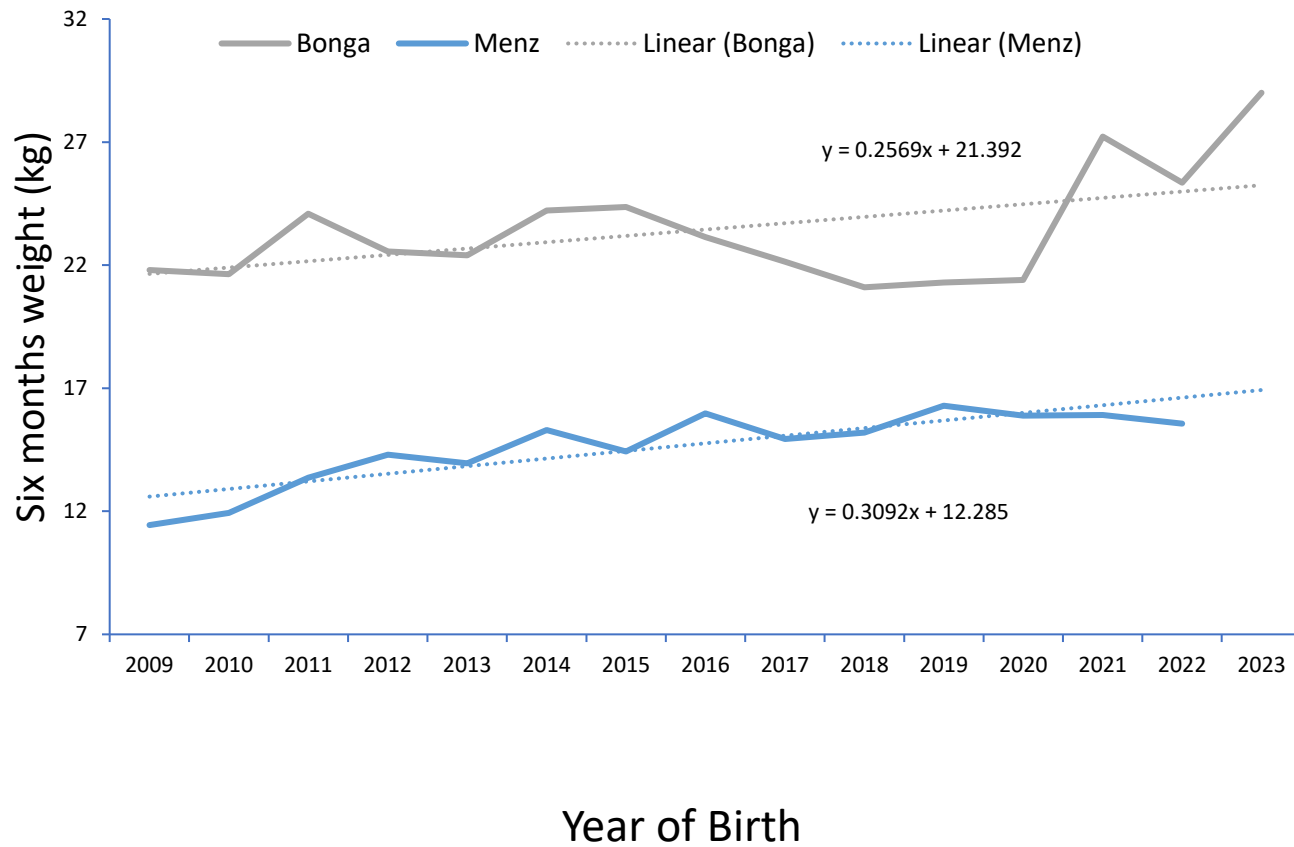
Genetic trend by year of birth (LI) – Menz sheep



Genetic trend by year of birth (litter size) – Bonga sheep



Six months weight phenotypic trend





CLEANED is a static based model which assess multiple environmental impacts of a livestock enterprises on an annual basis.

Based on the “**minimum data entry**”, the tool calculates the environmental footprint of a livestock enterprise.

Works on EXCEL

The **key input** and parameter data needed in CLEANED include:

- Agro-Ecological Data
- Livestock Data
- Livestock Diet
- Crop Management

Parameters:

livestock, soil, GHG emission, water, ... parameters

Outputs:

The area of land required for feed production

Productivity – Total, /ha,

Soil and water impacts:

GHG emissions

Livestock input data – based on 1 CBBP ~1000 breeding ewes

Animal	Menz						Bonga					
	Baseline (2009)			Improved (2022/23)			Baseline (2009)			Improved (2022/23)		
	Herd composition (nr)	Weight (kg)	Average annual growth per animal (kg)	Herd composition (nr)	Weight (kg)	Average annual growth per animal (kg)	Herd composition (nr)	Weight (kg)	Average annual growth per animal (kg)	Herd composition (nr)	Weight (kg)	Average annual growth per animal (kg)
Ewes	12137	27	0.39	15230	30	0.39	15098	33	0.50	18942	25	0.39
Breeding ram	262	30	5	324	35	5	80	37	5	80	40	5
fattening rams	1634	35	8	3910	40	10	3840	44	15	6106	48	22
lambs	6540	11.4	9	9124	16.3	14	8963	20	19	14259	29	29

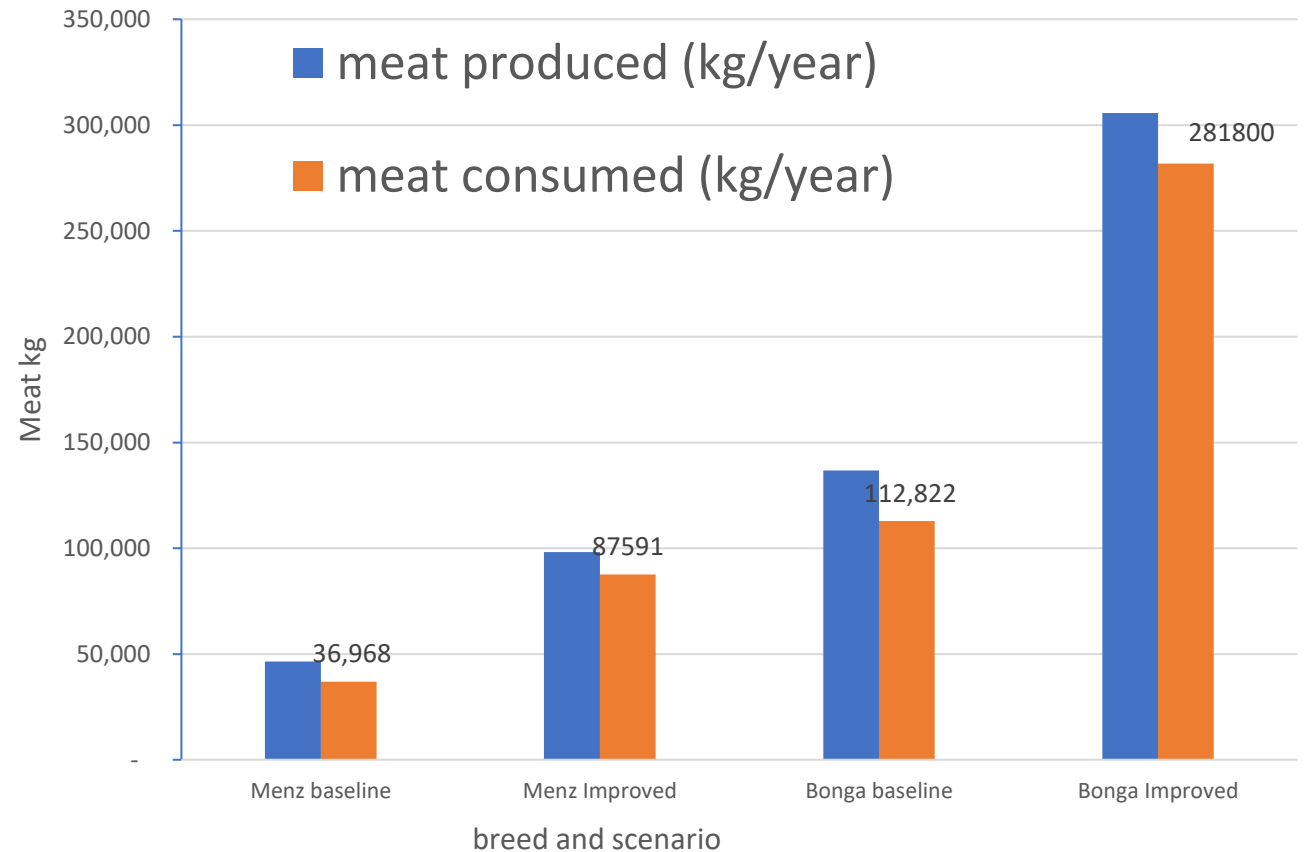
Both **baseline** and **improved** scenario were based on the ongoing CBBP. However, baseline refers the productivity level at the start of CBBP, 2009 and improved refers productivity level in 2022/23. Changes in productivity in terms of growth, lambing interval and animal survival were considered for each breed. Influence of a CBBP with 1000 breeding female considered

Wastage for baseline Menz, improved Menz, baseline Bonga and improved bonga were considered as **20%, 10% 17% and 7%**, respectively.

CLEANED output – Animal product

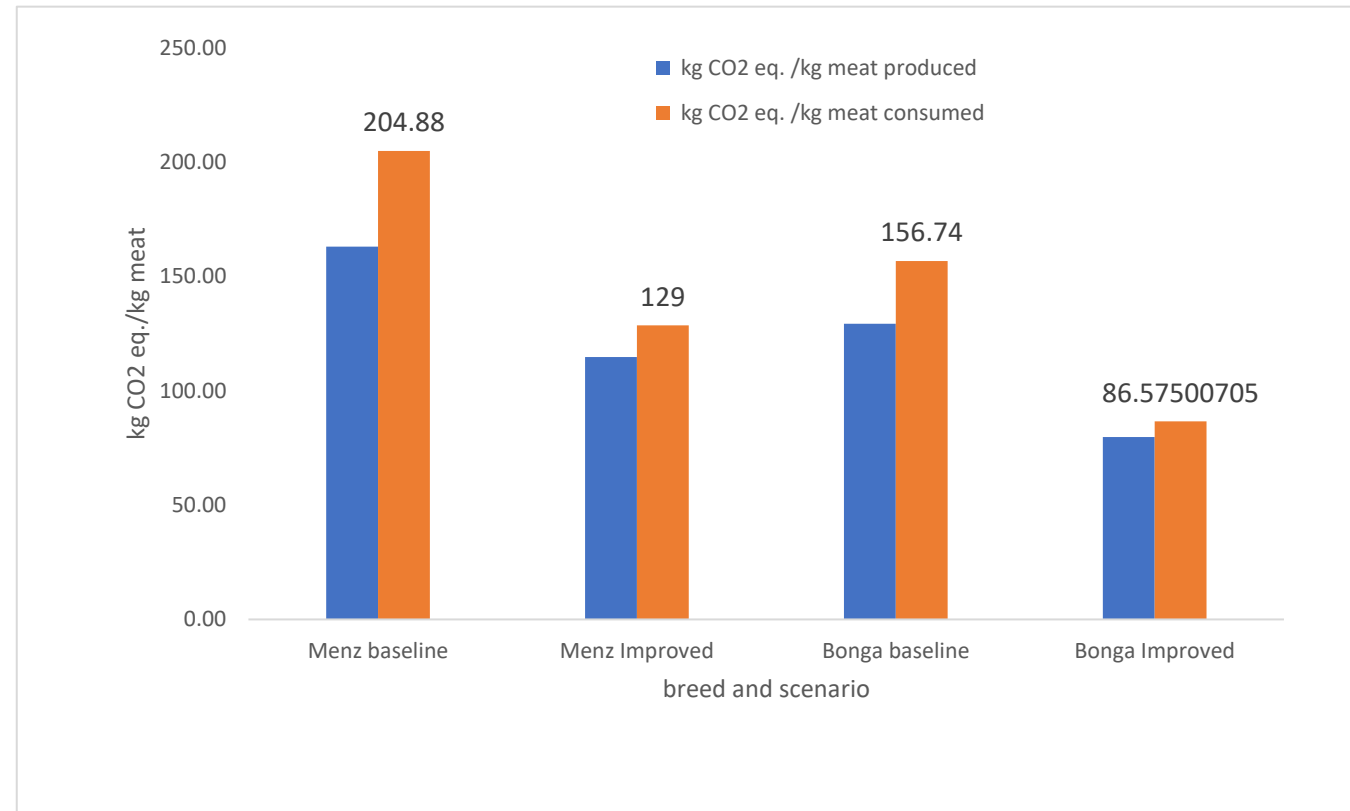
Meat produced and consumed

- Percentage change in Menz \approx 137.03%
- Percentage change in Bonga \approx 149.55%
- Percentage change Menz to Bonga \approx 221.66%



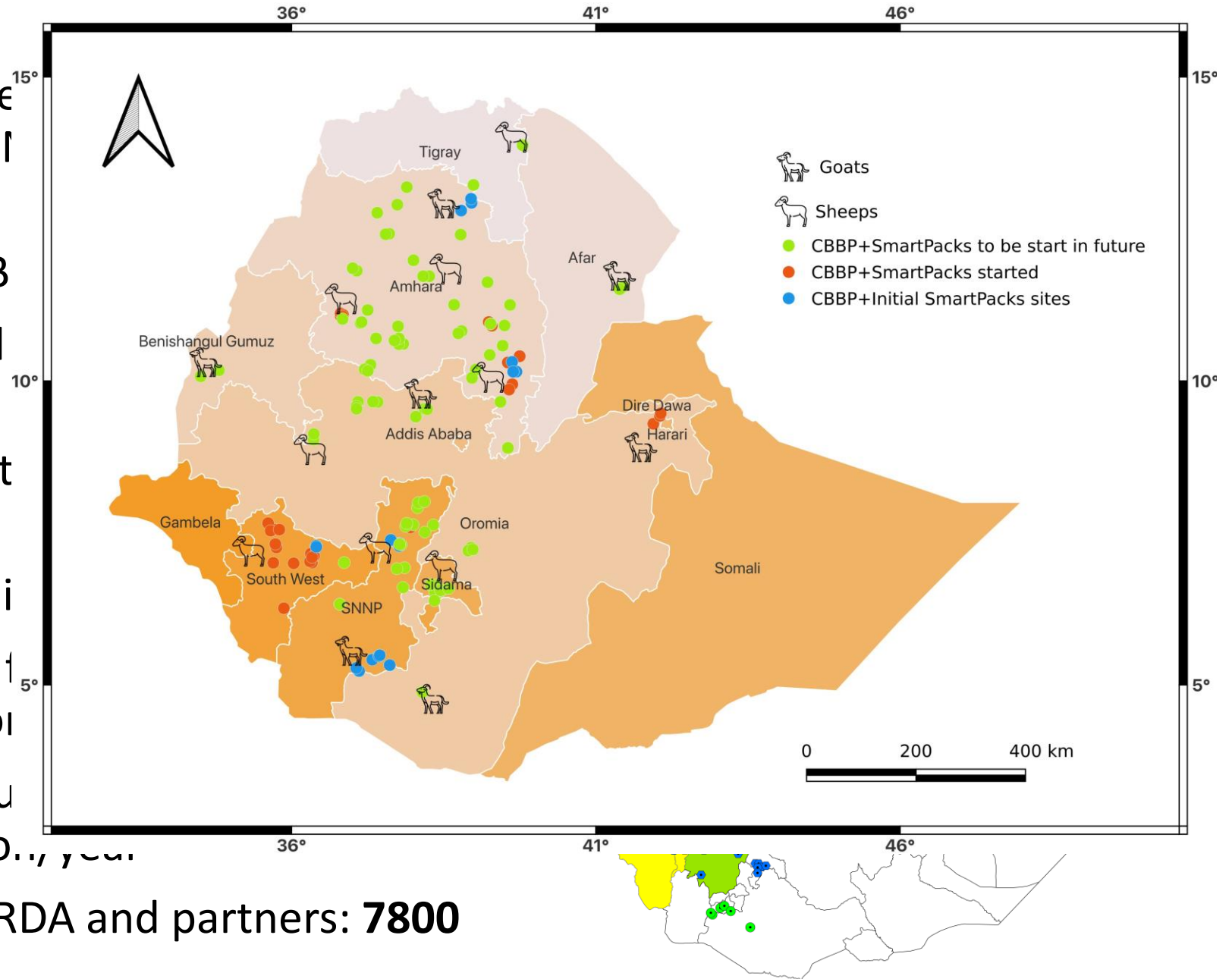
Results – Emission per product

- Percentage change due to improvement kg CO2 eq./kg meat in Bonga \approx -37.01%
- Percentage change due to improvement kg CO2 eq./kg meat in Bonga \approx -44.79%



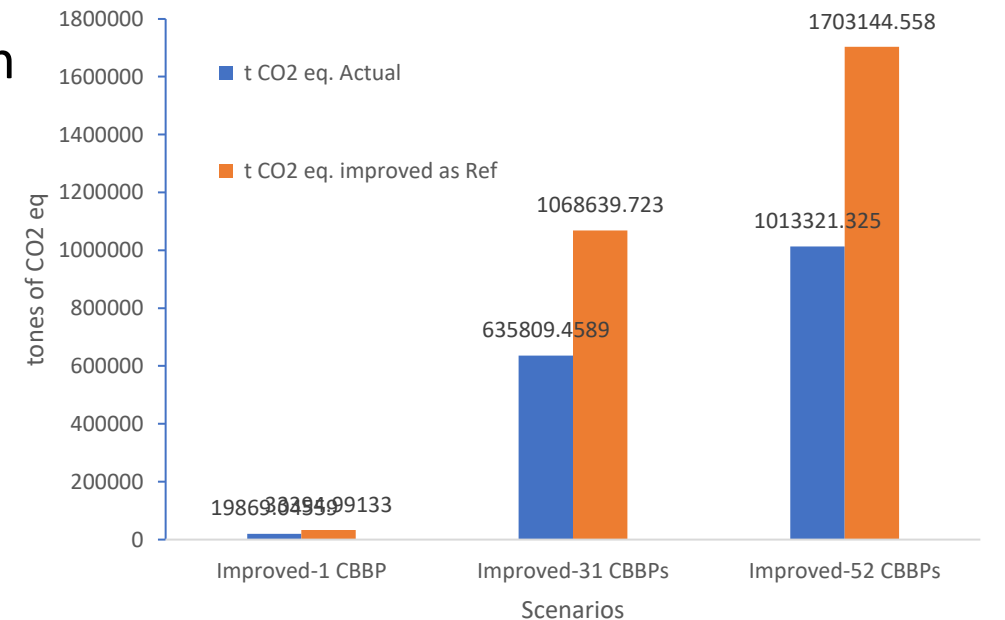
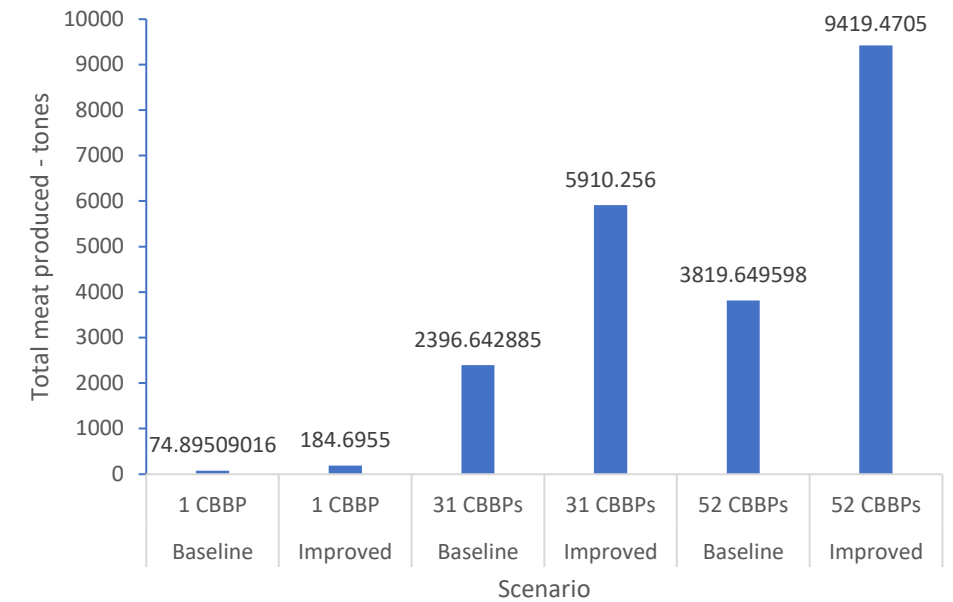
Scaling potential for Washera, Wollo, Bonga and Menz sheep

- Partner institutions involve universities, 6 research, 6 extension, 3 cooperative)
- Total existing dispersed CB
- Additional CBBPs required ewes: 111 CBBP
- Production capacity of exit the initiatives: 17,336
- Sires that could be dissemi
- Potential lambs produced t existing CBBPs: 1.13 Million
- When the scaling is fully fu lambs produced: 2.7 million, year
- Sires disseminated by ICARDA and partners: **7800**



Population level meat and GHG emission – Menz and Bonga sheep ~2 M sheep

- The improved scenario led to a significant increase in meat production, with a percentage change of ~ **146.57%**.
- In terms of environmental impact, the mean kilograms of CO2 emitted per kilogram of meat were **107.6** for the improved scenario and **180.8** for the baseline scenario – calculated from previous figure
- Comparatively, the improved scenario exhibited less environmental influence, as it required less CO2 production to produce the same amount of meat.
 - The baseline scenario resulted in a significant increase of approximately **432,830** tons of CO2 eq. emissions, representing a percentage change of approximately **68%** compared to the improved scenario in 31 CBBPs
 - Full potential – 52 CBBPs resulted in a significant increase of approximately **634,504** tons of CO2 eq., - **59.36%** compared to the improved scenario.



Conclusion:

- These findings highlighted the considerable benefits of the CBBP in terms of both increased meat production and reduced environmental footprint
- The study's results can also provide valuable insights for policymakers, and stakeholders interested in promoting environmentally friendly agricultural practices

"Being "locally adapted" is not an excuse for poor performing.
Go for locally adapted and well performing, by breeding."

Professor Johann (Hans) Soelkner



Thank you!!!

